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the fossil stickleback from Nevada, *Gasterosteus leptosomus* Hay, with *Merriamella doryssa.* The species stands as *Gasterosteus doryssus.*

In the same *Contributions,* Dr. Gill gives an account of the habits of the miller's thumbs or blobs. He shows that *Uranidea* can not be maintained as a genus distinct from *Cottus* and that the common species must be called *Cottus richardsoni,* not *C. ictalops.*

In the *Transactions of the Wisconsin Academy of Science,* Mr. R. H. Johnson discusses the variations in number and size of the pylone cæca in Sun-fishes. In each species a variation of two or three was found. Thus in species as the rock bass, having on the average eight cæca, the number ranges from six to nine. In the calico bass, with nine, the number ranges from eight to eleven. DAVID STARR JORDAN.

THE INHERITANCE OF SEX IN HIGHER PLANTS

Digest of Professor C. Correns's Memoir.[1]—It is stated in the preface that there is given here a more detailed reiteration of a report made September 18, 1907, to the united sections for zoology and botany of the German Naturalists in Dresden. Experiments in cross-breeding closely related species of plants of different sexual type, carried on since 1900, led to such remarkable results that an account was long withheld. When a repetition of experiments yielded like results, and a reconsideration of the deductions made revealed no flaws, conclusions were announced. For the plants examined the results are regarded decisive; but their wider application must be ascertained by further investigation.

Correns refrains from an historical review of the literature and attempts merely to present some new facts and relate them to previous facts. He does not wish, nor does he claim to be able, to construct a new theory regarding the nature of sex. He believes that there is much in common between his results and those reported by E. B. Wilson for Hemiptera. Finally he explains that by "anlage" of an organ as used in his paper he does not mean the earliest visible developmental stage, but the representative of the organ in the germ-plasm.

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[1] "Die Bestimmung und Vererbung des Geschlechtes nach neuen Versuchen mit hoheren Pflanzen." Abstract presented before a recent meeting of the Medico-Biological Journal Club of the University of Virginia, by H. E. Jordan, adjunct professor of anatomy.

In the introduction Correns notes that the present opinions concerning sex-determination are built largely upon the results (chiefly negative) obtained from attempts to control or alter sex, and upon observations on parthenogenetically developing eggs; in part also upon morphological and statistical data. The main object of his paper is to describe attempts to discover by experimental methods, whether the germ-cells have from the beginning a fixed sex-tendency and if so of what kind, and what rôle fertilization plays in sex-determination. He regards these as fundamental questions which must be answered before one can judge intelligently of the effects of unusual external influences. For the elucidation of these same questions he believes we are largely limited to the plants, particularly the flowering plants, due to the more favorable material they offer for experimentation.

In essence, the fertilization process in plants and animals is the same: two germ-cells unite to form a new organism. Botanists are to-day convinced of the polyphyletic origin of plants and, while it is possible, it is not very probable that sex-determination and sex-inheritance were arrived at in the different groups by the same path of differentiation. A question to be settled by further work, therefore, is whether the principles determined for the particular flowering plants under consideration apply also to other groups of plants, and also to animals.

Already in mosses are found a sharply expressed differentiation of germ-cells into egg-cells and sperm-cells, and this specialization is retained with various slight modifications throughout all the higher groups. In phylogenetically lower forms than the mosses the gametes are all alike (swarm spores). Chance or chemotactic influences may bring such into contact and subsequent union, or they may germinate asexually as in Protosiphon according to Klebs. Externally all are alike. Sometimes, as observed by Klebs in Chlorocytrium, cells from the same mother-cell may copulate. The question arises whether they are intrinsically alike or whether they consist of two classes, + and —, as Blakeslee proposes. In the first case every gamete may copulate with any other and there is sexuality but no sex-differentiation. In the second case only + and — gametes can copulate and sex-differentiation obtains, the foundation for further differentiation into egg and sperm not now externally visible. Further development may proceed along different paths. Differentiation may arise between individuals, + and — gametes being then localized in separate members, and the gametes of these same plants may be mutually incapable of union so that only gametes of different plants can copulate. These are here + and — individuals, but the gametes may give no external evidence of a difference. This is the case in Dasycladus according to Berthold and in Ulothrix according to Dodel. Or there may arise differences between the gametes, the one becoming, by the surrender of motility and the assumption of nutritive functions, an egg cell; the other, remaining small and retaining motility, becoming a spermatozoon. Thus hidden differences between + and — germ-cells become conspicuous and there appear ''female'' gametes and ''male'' gametes. When the specialized gametes are combined in the same plant it becomes hermaphrodite or monoecious; when separted, dioecious forms appear.

Correns lays emphasis on several points: (1) That the differentiation of gametes into egg and sperm has nothing to do with the union of the two germ-cells for the production of a new individual; or, in other words, that the externally visible differences between egg and sperm need have no connection with the process of fertilization; (2) individuals may be differentiated into males and females without an evident external mark of differentiation either in the individuals themselves or in their germ-cells. The various differential characters of eggs and sperm-cells and all other visible differences between male and female individuals reveal only their different nature, but do not touch the essence of sex itself. Interesting confirmatory observations in this connection are those of Blakeslee on Mucorineæ.

Originally there is present only the ''determination'' in the germ-cells which renders possible the union of some pairs of germ-cells and prevents the union of other pairs. All else is of a secondary character. With few exceptions the higher animals are unisexual. Among the higher plants many different sexual types occur. Neglecting transition conditions, the main types are hermaphrodite forms where stamens and pistils are united in the same flower; bisexual or monoecious forms, where pistils and stamens are separated into female and male flowers; unisexual or dioecious forms, where the male and female flowers are borne by different individuals. By far the larger majority of flowering plants have hermaphrodite flowers. Separation of sexual organs on different flowers or different individuals appears here and there as characteristic of entire families, and relatively often as a specific character, or sometimes only as a variation; and this in the most distantly related groups.

Correns entertains no doubt that hermaphroditism is the primary type and dioeciousness the derived. He does not regard as conclusive the arguments advanced by Coulter and Chamberlain that it is impossible to decide which is the primary condition since dioeciousness appears in both the quite low and the higher groups of flowering plants, being related in the former to wind-pollination and in the latter connected with insect-pollination. He observes that sex-separation appears also in other groups without any relation to the high or low degree of other characters. The dioecious condition arises in consequence of the physiological or morphological disappearance of one or the other set of members of the hermaphrodite condition. The "degeneration" of a sexual organ here is really nothing else than an arrest at a certain stage in the development of one or the other element in the hermaphrodite flower (Hofmeister; Goebel), thus producing the monoecious or dioecious conditions. Such change naturally does not proceed without an alteration of the idioplasm of the species involved; the "anlagen complex" of one element must become more or less incapable of development, or latent. As far as we know this process follows independently in both sexes and, in each, internal and external alterations stand in intimate correlation. Male and female flowers of monoecious species are of like high development. The female is not a male arrested at a lower stage of development. The great differences in size and vitality between germ-cells must be regarded as adaptations.

The main points involved in the problem of this investigation concern the *method by which* sex is determined and the *time when* such determination takes place. Since the embryonic and the adult sex-organs contain the anlagen for the characters of both sexes, sex-determination has to do with the question as to which anlage, male or female, shall develop. These conditions demand that the germ-cells have a fixed sex-tendency already before their union at fertilization. Correns emphasizes also that one must not here think of a separation and distribution of anlagen for the sex-characters into separate germ-cells in the sense that into one animal wander testes-anlagen (determinants of Weismann) and into another ovary-anlagen. This as far as we know is not the case. Both germ-cells carry both sets of sex-characters, as experiments with hybrids abundantly show. That a germ-cell has male or female sex-tendency means only that the male or female anlagen are in condition of capability to develop. As to how one anlage in the germ-cells becomes active and the other is brought to a latent condition we have no positive knowledge.

One may entertain several possibilities respecting the time that sex is determined. He may take the position that the germ-cells have held from the beginning the tendency to develop into one or the other sex—which sex becomes apparent when caused to develop by artificial parthenogenesis—and that the tendency remains unchanged by fertilization; in other words, that the germ-cells are unalterably fixed as to their sex-tendency and thus independently determine the sex of their offspring pure: ''pro-game'' determination. Either all the sperm or all the eggs are so determined or only a part of each. Such predestination is commonly ascribed to the egg, and the sperm is thought to be without influence. Accordingly, half the eggs must be male and half female in tendency.

The second position ascribes to the germ-cells before fertilization no fixed tendency to develop into a particular sex, and holds that only at fertilization is the decision made as to what sex the offspring shall have: pure ''syngame'' determination.

According to the third position the product of the union of the two germ-cells has no fixed sex-tendency. External influences determine only during the later stages of development what the sex of the offspring shall be: pure ''epigame'' determination. Theoretically an ''epigame'' alteration of sex must be possible, since the embryo contains both sex-anlagen. All critical investigations, however, both zoological (O. Schultz) and botanical (E. Strasburger), indicate that the means thus far employed in attempting to produce an alteration of sex-tendency have yielded no significant results respecting the actual separation of sex-organs among different individuals. Primarily, attempts must be made to determine whether the germ-cells of unisexual forms have an indifferent sex-tendency or whether they have a fixed tendency. If the latter condition prevails, it is incumbent next to determine what this tendency is. There are several possibilities: (1) The germ-cells may have the sex-tendency of the plant from which they came, the egg-cells the female, the sperm-cells the male; (2) they may have the opposite sex-tendency; or (3) some of the eggs may be of one sex-tendency and a part of the other, and likewise the sperm. A further problem arises as to how far fertilization plays a rôle in sex-determination, since thus germ-cells of different sex-tendencies may unite; and also how far external influences have significance in that they can act upon the sex-tendency of the germ-cells before fertilization, or at the time of fertilization upon the united product, or after fertilization on the embryo.

Whether a given germ-cell contains a fixed sex-tendency can best be ascertained when such a cell can be caused to develop without fertilization into a sexually mature individual. Such conditions obtain in cases of "habitual parthenogenesis." The facts here at first sight seem to compel acceptance of the position that the sperm-cells play no rôle. However, on closer scrutiny of the facts, doubts are raised as to the validity of such an interpretation. One must not forget that generally eggs that develop parthenogenetically do not undergo a reduction division. Correns states that whatever significance one may attach to reduction, he can not regard such eggs as of like nature with those that have suffered maturation. In the case of "habitual parthenogenesis" one deals with phenomena of adaptation. Such adaptation may enable an egg to develop without fertilization even though this capacity depends only on the suspension of a check, which otherwise, through the intervention of a male germ-cell, could exert its influence. In similar manner the sex-tendency also may be influenced. Natural and artificial parthenogenesis yield an indication of the sex-tendency only of the egg. "Ephebogenetic" development of sperm-cells, theoretically possible, but practically thus far beset with insuperable difficulties, is urgently required. Merogony furnishes no positive results until we know definitely the rôle of cytoplasm, as distinct from karyoplasm, in heredity.

Correns turns into other fields which seem to lead farther than experiments with artificial parthenogenesis, namely, hybridization. The controlling idea of Correns's investigation is the following: The egg-cells of a diœcious form whose sex-tendency we desire to ascertain, is commonly fertilized by a sperm-cell of the same species. The sex-tendency of both gametes is unknown. On the other hand, the sex of the offspring resulting from the union of the gametes becomes obvious. In other words by the interaction (in union) of two unknown quantities, X and Y, *i. e.*, the sex-tendencies of the two gametes, there results an organism of known sex; or $x + y =$ sex of organism. Could the value of either x or y be ascertained the equation could be solved and the value of the other unknown quantity determined. These values Correns obtains in the case of the germ-cells of two favorable, nearly related, species of plants one of which is hermaphrodite and the other diœcious. The above figure is not quite accurate, as Correns point out, since a solution of the equation is possible only when the unknown sex-tendency of the germ-cell of diœcious type, as over against the known sex-tendency of the hermaphrodite germ-cell, is so strong as to wholly or almost entirely prevent the development of the latter or to greatly suppress it. The conditions are fully met in those cases where the sperm-cell of a white-flowering pea by fertilization makes possible the development of the egg-cell of a red-flowering pea, so that a red-flowering plant results without showing a trace of the white factor of the sperm. Thus is obtained the effect of artificial parthenogenesis, not only on the egg cell but also on the sperm-cell.

The germ-cells of hermaphrodite forms carry the hermaphrodite sex-tendency and give rise only to hermaphrodite forms. Correns does not regard a hermaphrodite individual as a ''mosaic'' derived from the union of a germ-cell of male tendency with one of female tendency. However, they must contain the anlagen of such a mosaic. Hermaphrodite germ-cells contain only the hermaphrodite sex-tendency both in the egg-cells and in the sperm-cells. Likewise for monœcious forms, where on the same individual two kinds of sexual flowers appear, male and female, the same position must be taken; *i. e.*, that both kinds of germ-cells, eggs and sperm, carry the same tendency, namely, the tendency to develop into monœcious forms. Each germ-cell thus carries over not the sex of the flower from which it came, but that of the entire plant on which the sexual flowers appeared.

There remains no doubt concerning the monœcious tendency of the germ-cells of monœcious plants. Correns cites in further support of this position the case of *Dimorphotheca pluvialis,* a "trimonœcious" form where flowers of three kinds, male, female and hermaphrodite, occur in the same head. Since we have here two kinds of sperm-cells (pollen), one from the hermaphrodite flower and one from the male flower, and also two kinds of eggs, embryos can arise in four different ways. If the germ-cells had different sex-tendencies after they are built into a male, a hermaphrodite, or a female flower, four kinds of offspring would arise. All the seed, however, produce the same kind of offspring,- *i. e.,* trimonœcious forms. Therefore all the germ-cells of Dimorphotheca must bear the tendency again to give origin to trimonœcious plants. It may be said then, that all germ-cells of a hermaphrodite plant have the tendency again to develop into hermaphrodite plants, whether they be found in stamens or pistils. All germ-cells of monœcious forms have the tendency again to produce monœcious forms whether they arise in male or female flowers. We know, then, the tendency of the germ-cells in hermaphrodite and monœcious types and we can employ these known quantities to ascertain by cross-breeding the unknown tendency of the germ-cells of unisexual plants.

In the first three experiments Dr. Correns employed two species of Bryonia, a genus of the Cucurbitaceæ, growing wild in central Europe. *Bryonia alba* bears a black fruit and is monœcious. *Bryonia dioica* bears a red fruit and is diœcious. In the first experiment (A) he pollinated the pistils (egg-cells) of *Bryonia dioica* with the pollen of *Bryonia alba.* He obtained eleven hybrid offspring from the seed, all female plants and perfectly sterile. These results disclose the following facts: (1) That monœciousness was here recessive to the diœcious conditions; (2) that the egg-cells of *B. dioica* had before fertilization, "progame," a fixed sex-tendency, and all of the same kind. Were this not the case, not all the offspring could have attained the same sex. Had both anlagen, those of the male and those of the female sex, been equally active in the eggs and had a decision as to the definitive sex depended upon a struggle between the anlagen (or upon external influences), the hybrid offspring would have been of dissimilar sexes; (3) the egg-cell has the tendency to develop into a female plant; also the tendency to give origin to such plants as those from which it arose; the physiological sex-determination and the developmental tendency are both female.

The second experiment (B) consisted in fertilizing the egg-cells of *Bryonia dioica* (using flowers from the same plant as used in Experiment A) with pollen from the same species. Of 67 seedlings in the first year 41 came to flower, 21 being male and 20 female, all pure *B. dioica.* Combining the results of this experiment with those of experiment A it becomes positive that the egg-cell possessed a definite sex-tendency, and that the sex was not, however, unalterably determined in it; otherwise in experiment B all the offspring would have become female as in experiment A. The sperm-cells also must have played a rôle in the sex-determination, since until the time of impregnation of the eggs by the male gametes the conditions of both experiments were the same. As far as this experiment discloses, all the pollen-grains might have carried the male tendency. After union with the egg-cells of female sex-tendency a struggle may be conceived to have proceeded, the victory coming now to the female tendency, and now to the male, so that the final outcome resulted in 50 per cent. individuals with definite male characters and 50 per cent individuals with female characters. That this was not the case, the third experiment (C) makes clear.

In experiment C, female flowers of *Bryonia alba* were pollinated by male flowers of *B. dioica.* In other words, *B. alba* furnished the egg-cells and *B. dioica* the sperm-cells. The fruit of the cross was black, and of 87 seedlings, 76 came to bloom the first year, 38 of which were female and 38 male. All the plants showed hybrid characters and were completely sterile. The decision in regard to the sex of the hybrid must have been brought about through the influence of the male gamete (pollen) as in experiment B, since *B. alba* self-pollinated gives rise only to monœcious plants. There is here a second point in evidence, unconnected with the first, against the unalterable "progame" determination of the egg-cells, and in favor of ascribing definite influence to the sperm-cells and to fertilization. The pollen-grains of *B. dioica* can not all have been alike in regard to sex-tendency, else the offspring would all have been of the same sex, since the egg cells of *B. alba* were all alike in their tendency to give origin to monœcious forms. Again, not all the pollen-grains of *B. dioica* can have had the same sex-tendency, else all hybrids, due to the dominance of diœciousness, would have had the same sex. Nor can they have been endowed merely with the tendency of diœciousness, but without a tendency for a particular sex. Nor can the sex of the hybrid have been determined by the union alone, else in experiment B, where these male gametes united with female gametes all with fixed sex-tendency (the female tendency as determined in experiment A), all offspring would have been alike female plants. Thus there remains only this interpretation: That half of the pollen-grains of *B. dioica* were endowed with the male tendency and half with the female tendency. Since half of the offspring were male and half female, and all of the eggs were of the same sex-tendency, there can not have occurred a struggle for supremacy between the anlagen of the two tendencies (such a condition would yield 75 per cent. female plants and 25 per cent. male plants) but the male sex-tendency must have dominated completely over the female tendency. Sex-determination is thus "progame" and "syngame" alike, but the decision comes "syngame."

Experiments were repeated with *B. dioica* from widely separated regions. Different plants of *B. alba* were also employed. Dr. Correns has had under observation about 1,000 of these hybrids. In 27 experiments, using 16 female plants of *B. dioica* from various regions and 4 plants of *B. alba,* 589 plants were raised and all were females. In 17 experiments, using 5 plants of *B. alba* from different regions and 10 plants of *B. dioica,* 358 hybrids appeared, 171 pure males and 187 pure females. In the body of his paper Correns discusses numerous possible objections and criticisms that might be made in respect to his experiments and the interpretation he gives to his results. All such objections and criticisms are met with very keen and reasonable explanations.

Correns made a fourth series of experiments (D) in which he used plants from a family of only distant relationship to the Cucurbitaceæ. These were a kind of pink, *Melandrium album,* and a plant from a closely related genus, *Silene viscosa.* The former is a diœcious form and Silene is hermaphrodite. Of the seedlings from this cross, using Melandrium as the female parent and Silene as the male, 27 plants came to bloom. They were all female, though in other respects hybrid in character, and sterile. In another experiment (E) Melandrium was fertilized with pollen from its own species (as in experiment E) and there appeared approximately 50 per cent. male plants and 50 per cent. female. The parallel of experiment C with Bryonia was also attempted between Melandrium and Silene, using the latter as the female parent (the hermaphrodite flowers were castrated) and Melandrium as the male parent. All the seed from this cross was sterile.

Numerous experiments with phylogenetic transition forms (''polyams'') between hermaphrodite and monœcious flowering plants on the one hand and hermaphrodite and diœcious forms on the other, *i. e.,* andromonœcious, trimonœcious and gynomonœcious forms—also with androdiœcious, triœcious and gynodiœcious forms—yielded results less definite, it is true, but nevertheless confirmatory (especially as regards the female tendency of the egg-cells of the female plant) of those obtained from hybridization experiments between the end forms as in Bryonia Melandrium and Silene.

The main results may be summarized under three heads: (1) The germ-cells of female individuals all have the tendency to develop into female plants; one half of the germ-cells of the male individuals have the tendency to develop into male plants and one half into female. (2) The definitive sex-determination occurs at fertilization; the original tendency of the female germ-cells can be altered through the sex-tendency of the male germ-cells. (3) When at fertilization germ-cells of unlike sex-tendency unite, the male tendency dominates over the female.

The experiments seem to indicate that sex is inherited. Strictly speaking, however, one can not say that a plant has ''inherited'' sex, but only that the germ-cells have inherited sex-tendencies. Only the anlagen of sex are transmitted from generation to generation, not the characters (''Merkmale'')—the cloak that they have woven for themselves (Naegeli).

Had the hybrids of Bryonia, and those between *Melandrium album* and *Silene viscosa* not been sterile, they would undoubtedly have split up in such a way that the anlage of diœciousness would have been again separated from that of monœciousness and of hermaphroditism, respectively, and the second generation of these diœcious hybrids would have included pure diœcious, hybrid diœcious and pure monœcious (or hermaphrodite) individuals in the Mendelian proportion of 1:2:1. It remains a question whether the diœcious plants would all have had the sex of the diœcious parent or if both male and female plants would have appeared.

In all cases in which the offspring are divided approximately equal in respect to sex, and where the eggs show no external differentiating characters, as in the great majority of the diœcious Metazoa and man, there appears nothing to contravene the facts and hypotheses regarding sex-determination as presented in the foregoing description of the experiments with certain of the higher flowering plants. However, such cases as are presented by the aphids and the honey-bee, where all fertilized eggs develop into organisms of like sex, are disconcerting from the view-point of the above facts. Correns proposes that the drone eggs of the honey-bee are incapable of fertilization (develop parthenogenetically). He inclines also to the idea that all the eggs may have the male sex-tendency and that femaleness dominates. But since all fertilized eggs develop into females this necessitates, on the hypothesis that there are two kinds of sperm-cells, the further assumption of selective fertilization. The recent discoveries of Meves, Stevens and Morgan, that during spermatogenesis of the honey-bee, certain aphids and phylloxera, respectively, one half of the spermatozoa degenerate (and these probably are the male-producing kind) now brings these cases into very close harmony with Correns's observations on plants. Thus all fertilized eggs must develop into females. The disturbing question still remains as to just how a parthenogenetic female aphid can produce male offspring.

Again when two kinds of eggs are produced, as by phylloxera, daphnids and rotifers, the larger invariably develop (parthenogenetically) into females and the smaller into males. Correns believes that here a proportion of the eggs may have become altered (''umgestimmt'') in sex-tendency and that their size-difference stands in correlation with the difference in size of the female and male individuals. In phylloxera this difference, however, does not seem significant. *Dinophilus apatris* seems to be a real exception to the hypothesis that sex is determined by the spermatozoon. Nevertheless, Correns suggests that a portion of the eggs, in consequence of a subsequent alteration or originally, may have retained the male sex tendency; or selective fertilization may obtain, so that only the larger eggs are fertilized by female producing spermatozoa and the smaller by male producing. However, when caused to develop parthenogenetically large and small females appear, the difference in size of the eggs being related to size differences of the offspring and may have arisen through ''prospective'' adaptation. This argues for the influence of the spermatozoa in sex-determination and for selective fertilization.

While the facts regarding the honey-bee and Dinophilus offer serious obstacles for the general application of Correns's principles of sex-determination to plants and animals, he finds on the contrary much similarity between his results and the cytological findings of E. B. Wilson for many of the Hemiptera. Taking Protenor and assuming that the spermatozoon with the seven chromosomes (including the accessory) carries the recessive female tendency, and that the spermatozoon with six chromosomes carries the dominant male tendency, then the correspondence between the results is complete. The assumptions made at first sight seem inconsistent, but they appear more reasonable in the light of Correns's observations on *Satureia hortensis* where the female tendency—which becomes patent by reason of the latency of the anlage of the male tendency (in originally hermaphrodite forms)—dominates over the hermaphrodite tendency in crosses, when ordinarily the anlagen for hermaphroditism are active besides the passive anlagen for the female tendency (in gynomœcious forms).

Correns finds it difficult to believe that the idiochromosomes are the material vehicles of the sex-tendency, since the disappearance of the mate of the accessory chromosome in Protenor seems to show directly that it was no sex-determinant. Both germ-cells contribute both anlagen; the idiochromosomes can, therefore, simply aid the development of one sex-anlage or hinder the other. If we accept the idea that they are also the carriers of the sex-anlagen then the spermatozoon of Protenor with six chromosomes would have no sex-anlage; and ephebogenetically developed it would give rise to an organism without sex. If the anlagen are present outside of the idiochromosomes then the spermatozoon thus developed would give origin to a hermaphrodite form. There probably are not two kinds of eggs. The contrary assumption rests upon another; *i. e.,* selective fertilization. There is no experimental evidence of selective fertilization in the case of Hemiptera. If one accepts Wilson's suggestion that in cases like Nezara (where the idiochromosomes are alike) half of the spermatozoa have an active idiochromosome (aiding the development of the female sex) and half a passive one (permitting the male sex to develop), and that the latter may, in consequence of its passivity become reduced (as in

Lygaeus), or have entirely disappeared (as in Protenor), all the eggs may then carry idiochromosomes of like activity and there is no need for selective fertilization. These cases accordingly seem to lend themselves for interpretation very well to the principles above stated for sex-determination in Bryonia. In Mendelian terminology, females are pure zygotes, *i. e.,* homozygotes; males are hybrids, *i. e.,* heterozygotes. Segregation takes place at maturation and produces by the homozygote organism one kinds of germ cells and by the heterozygote two kinds, *i. e.,* male and female in sex-tendency.

The physiological male or female property of the germ-cells which provides for their union and what relates thereto, must not be confounded with the male and female tendency of the germ-cells, or the disposition to give rise to descendants whose germ-cells are again male or female. Though these principles of sex-determination and inheritance discovered for higher plants may not be capable of universal application, there are several points in which the different methods may agree: (1) That each germ-cell has originally a fixed sex-tendency; (2) that the germ-cells of one sex (either the male or the female) have only one and the same sex-tendency, and those of the other partly the one, and partly the other; and (3) that a primarily fixed differentiation in the developmental vigor of the germ cells with different sex-tendencies that unite at fertilization, brings about a decision favorable to one or the other sex.

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